

THE HISTORY OF THE DEVELOPMENT OF THE PACIFIC OYSTER, *CRASSOSTREA GIGAS* (THUNBERG) INDUSTRY IN SOUTH AUSTRALIA

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Summary

OLSEN, A. M. (1994) The history of the development of the Pacific oyster *Crassostrea gigas* (Thunberg) industry in South Australia. *Trans. R. Soc. S. Aust.* 118(4) 253-259, 30 November, 1994.

The dredge fishery for the native mud oyster *Ostrea angasi* Sowerby in South Australia had a chequered history before finally collapsing in 1945. Attempts to cultivate the native oyster on leases were only partially successful. The importation of seed oysters of the Pacific oyster *Crassostrea gigas* from Japan in April 1970 by a private company began the successful aquaculture of this rock oyster. The aquaculture of the Pacific oyster has filled the market niche left by the loss of the mud oyster fishery.

The background history of the several introductions of seed oysters (spat) from Japan, Tasmania and Scotland is described.

KEY WORDS: Pacific oyster, *Crassostrea gigas*, history, introduction, South Australia.

Introduction

From the early days of the colony, oysters were being marketed from beds on the western side of Gulf St Vincent and the northern side of Kangaroo Island. By 1871 the dredge fishery was concentrating on oyster beds in Kellidie Bay where 30 sailing vessels employing 80 men were dredging 60 thousand bushels of oysters a year. Overfishing of the stocks occurred and by the late 1880s the fleet moved to new beds near Stansbury. Within a few years these beds were also depleted and the few remaining vessels moved back to the Eyre Peninsula beds so that by 1905 the mud oyster fishery had virtually collapsed. Over the next 25 years, when old beds showed signs of recovery boats entered the fishery only to leave later. In 1945 the mud oyster fishery ceased to exist (Olsen and Priest 1971; Wallace-Carter 1987).

Attempts to cultivate the native oyster at Stansbury and Kellidie Bay were only partially successful with the output limited by low recruitment. Mud (incubatory) oysters have a low fecundity compared with that of the mass spawnings and spat settlement of the rock (non-incubatory) oysters such as *Saccostrea commercialis* (Iredale and Roughley), the commercially important Sydney rock oyster and the introduced Pacific oyster *Crassostrea gigas*.

Early attempts to grow rock oysters in southern Australia

An attempt in 1886-7 to acclimatise the Sydney rock oyster at Hobart, Tasmania was unsuccessful (Saville-Kent 1887). A trial shipment of the same species spread

out on trays at Kelso, River Tamar, in northern Tasmania in 1948 by a Sydney rock oyster grower failed too (Olsen 1965).

In 1933-4 attempts were made to cultivate young Sydney Rock oysters on a commercial scale in South Australian waters. 228,000 oysters were laid out on trays off the west bank of the Port River below the Osborne Power Station where an earlier experimental consignment had reportedly grown very fast (Anon. 1934¹; Wallace-Carter 1987). Other attempts to acclimatise the Sydney rock oysters were made in 1937 at Mt Dutton and Kellidie Bays without success.

A small consignment of juvenile Sydney rock oysters from a warm water environment at a solar saltfield at Port Alma, Queensland was transferred in May 1976 into seawater of approximately similar salinity and temperature of the primary pond of the solar saltfield at Dry Creek. Within 3 months 95% of the experimental consignment died. Later the same year a second experimental consignment was transferred from the same source and these oysters suffered 70% mortality within a month. As a result of these experiments further translocation experiments into quarantine areas at Dry Creek ceased (Melvin per comm.).

So far as the author is aware the last attempt to acclimatise Sydney rock oysters in South Australia was in 1977 when oysters put into the commercial prawn farm ponds at Port Broughton failed.

Thomson (1952) remarked that conditions of the waters of the southern states are outside the natural range of the Sydney rock oyster.

When CSIRO Division of Fisheries and Oceanography imported Pacific oysters from Japan between 1947 and 1952, the author assisted with their establishment and supervision and, in September 1953, the transfer of the majority of the surviving stock to Port Sorell. It was on the basis of this experience that

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¹ ANON. (1934) Large scale farming of Sydney rock oysters in Port River. "The Saturday Mail" 14 July, 1934.

the author in 1968 considered the aquaculture of the Pacific oyster would be successful in South Australia. The Pacific oyster was already established as a viable reproducing stock on the rocky foreshore of the River Tamar near Sidmouth in Tasmania (Thomson 1959). By 1964 the Tasmanian authorities were granting leases for its commercial production. (Fig. 1).

At its January 24, 1968 meeting, the Flora and Fauna Advisory Committee, a body responsible to the Minister for Agriculture, South Australia, examined a proposal from the Director of Fisheries and Fauna Conservation Department for Pacific oysters to be introduced from Tasmania for aquaculture in South Australian waters. It was argued that the Tasmanian stock was disease-free and its introduction could fill a niche no longer occupied by the native mud oysters. The Committee did not raise any objections to the recommendation. The Department itself did not have the staff or funds to undertake the import and establishment of the Pacific oyster but wanted to be able to encourage private enterprise to do so.

In June 1968, J. T. Belling of Balaklava asked the Department whether an oyster lease, currently held by W. Lee of Kellidie Bay, could be transferred to another company of seven shareholders who wished to expand production of the native mud oyster. There was no objection and subsequently Oyster Farmers Coffin Bay Pty Ltd was registered as lessee of the Kellidie Bay oyster lease.

Later in the year two Adelaide men, C. J. Mack and R. C. Sprigg, also approached the Department about

obtaining leases for experimental oyster production. The author suggested they meet J. T. Belling to discuss the problems associated with cultivation of mud oysters. He also suggested that they might like to combine and import a consignment of Pacific oysters from Tasmania. The group was advised to visit Wivell Bros' Tasmanian Rock Oyster Company at Sidmouth, River Tamar, to see the techniques used there and to find out about the transport of oysters to Adelaide. After a visit by the men to Wivell Bros in March 1969, an order was placed with the company for 50 bags, each containing about 120 adult oysters for delivery to South Australia in September 1969.

After their return, arrangements were made with R. C. Sprigg's organisation, Geosurveys Pty Ltd for its workshop to make and tar oyster trays. Tared trays were taken to Sprigg's site at Coobowie and Mack's at Kangaroo Island which had been preselected so that the trays could be attached to stakes, above the sea floor, but situated below water level at low tide.

The 15 bags purchased for Mack's lease were set out above a seagrass bed (*Zostera muelleri*) at 0, 1 and 2 m below low water near Picnic Point, American River, Kangaroo Island and Sprigg's were set out below low water off the Coobowie Marine Research Station, Yorke Peninsula. The remaining 20 bags were taken by truck and laid out on the Oyster Farmers Coffin Bay Pty Ltd lease at Kellidie Bay, Eyre Peninsula. The adult oysters all acclimatised and grew well. Although they spawned three months after being set out no spat settled at or near any of the three leases.

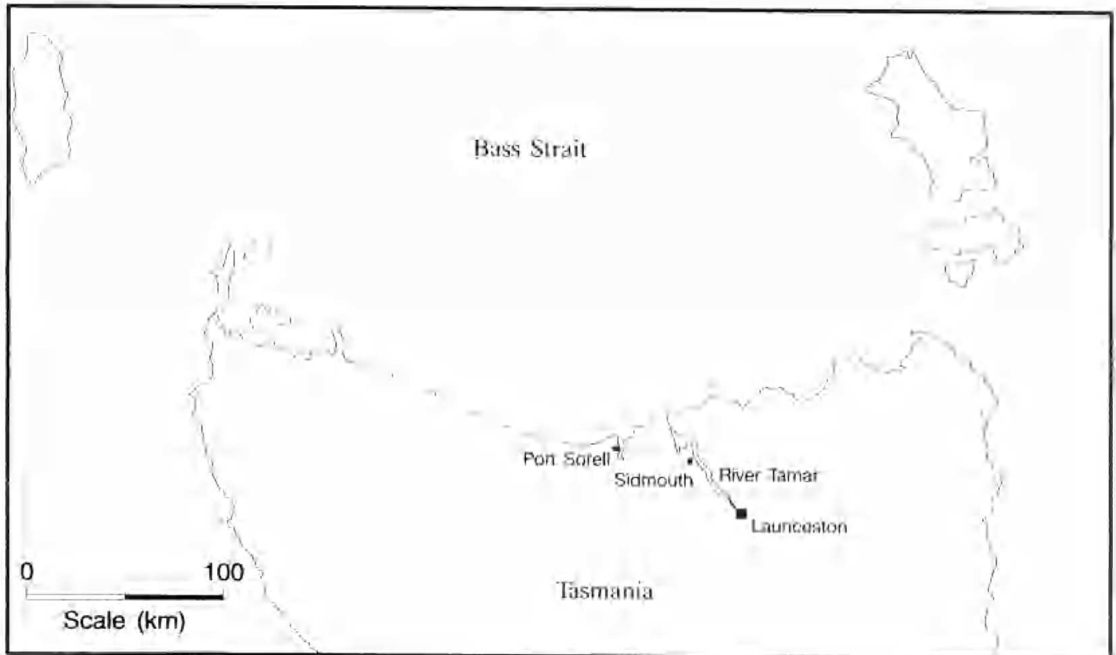


Fig. 1. Locations in Tasmania of spawning wild populations of Pacific oysters.

Environmental conditions including high salinities (35 ppt) must have been inimical to the survival and settlement of larvae of the Pacific oyster. Many commercial hatcheries operate at salinities of 32-34 ppt or even 36 ppt and salinities of 30-34 ppt are reported from seed-producing areas in Japan and from areas of France where *C. gigas* reproduces successfully (Coleman, 1986). However, continuous exposure to salinities greater than 32 ppt is lethal to Pacific oyster larvae and according to Medcof and Wolf (1975) this is the reason there has been no spat fall in Coffin Bay, South Australia.

The sustained growth and excellent condition of the imported adults on the Oyster Farmers lease prompted the Company to consider importing Pacific oyster seed (spat) by air from Japan. One of the shareholders, who wrote and spoke Japanese fluently, flew to Japan to examine cultivation techniques first hand. While at Sendai, Miyagi Province, he sought details of air-freighting oyster spat to Adelaide. Full details of quality, quantity and costs from Sendai to Adelaide were received on February 23, 1970.

Importation of seed oysters (spat)

In early March an application to import a trial shipment of spat by air from Japan was lodged with the Chief Quarantine Officer (Animals), South Australia. Permission to import the spat was received on March 24, subject to compliance with all quarantine requirements. A 19 kg box containing 6000 Grade A unbroken oyster spat was ordered to be air-freighted to Adelaide and was received on April 12. Some minor problems with quarantine requirements were resolved quickly and the spat was released in good condition from quarantine on April 28 and set out on the Kellidie Bay lease.

A second application from Oyster Farmers Coffin Bay to import 100,000 certified disease-free oyster spat by air from Mitsui and Co. Ltd. Sendai, was lodged with the Department of Health, Canberra in August 1970 (Fig. 2). This was cheaper than buying and transporting the spat by sea from Tasmania.

In the second application the company wrote "the growth rate of this 1970 seed is proving to be excellent and we, therefore, wish to further our experiments with the rate of growth for production with view to sale. It is anticipated that 100,000 seed be imported in 1971 with follow-up quantities as and when considered appropriate. Our next consignment will be by air, however, we request permits to cover both AIR and SEA transport so that seed mortality during transit may be compared."

The application was refused by the Commonwealth-States Advisory Committee in February 1971. The

grounds for refusal were never made known despite a request for such from the South Australian Department. The introduction of certified disease-free oyster spat direct from Japan to South Australia did not pose a disease threat to the NSW oyster but the development of an oyster industry did pose a potential competitor for the NSW commercial oyster monopoly.

After the refusal to allow spat to be imported from Japan, Oyster Farmers Coffin Bay ordered 2000 "sticks" from Wivell Bros. These "sticks" are milled slates 2 metres long and 25 millimetres square. It was indeed fortunate that when the mass spawning of Pacific oysters from the higher trays occurred between January 26 and February 12, 1971, Wivell Bros had put out 87,000 tarred and cured "sticks". Consequently they had ample "sticks" to supply the order. A quantity of scallop shells (*Pecten alba*) were set out also as an alternative cultch material (Wivell pers. comm.).

In April, 1971, Oyster Farmers Coffin Bay received 2000 "sticks" holding 120,000 spat oysters along with a quantity of scallop shells averaging 15 spat/shell. The shell sample was included to see if transport costs could be reduced by using this alternative cultch material.

The following year another consignment of 800,000 spat on scallop shells was received on April 20. The 1971 spat oysters continued to flourish and by December 1972, the spat had reached commercial oyster size and were sold (Reschke 1972²). There was a ready local market for these 11 month old oysters and Pacific oysters from McIntyre's Stansbury lease were also being marketed. He had obtained his 1971 spat from Wivell Bros, Sidmouth.

In early 1972 a tentative order for Pacific oyster spat was received by Wivell from a Welshpool (Victoria) buyer. However, the order was cancelled later when permission to import into Victoria was refused on the grounds of possible transmission of diseases (Wivell, pers. comm.) although no disease had appeared in 1955 when a large number of Pacific oysters had been transferred by the Victorian fisheries authorities from Pittwater (Tasmania) to Mallacoota Inlet. After three years 74,000 oysters were still alive but there was no evidence of any spat fall (Thomson 1959).

Disaster, however, struck the Tamar River oyster industry in 1973 when there was virtually no spat fall at any of the recognised settlement areas in January-February that year. It is believed that higher salinities at the leases resulted in poor gonad development following a prolonged dry spell - the longest on record (Wivell pers. comm.) The lack of freshwater flows in the Esk tributaries of the River Tamar allowed marine water from Bass Strait to penetrate further into the estuary during the long dry spell. The developing South Australian oyster industry, dependent on spat from Tasmania, was halted as the 2 million spat order for April 1973 could not be filled.

²RESCHKE, W. (1972) The oystermen of Coffin Bay. "Sunday Mail" 22 April, 1972.

Oyster Farmers Coffin Bay attempted to produce their own spat for on-going operations with a small scale industry operation but were unsuccessful because of difficulties in providing suitable algal food for the developing larvae.

About the same time that advice was received that no Tasmanian spat were available, the SA Department of Fisheries received an enquiry from Pacific Aquaculture Pty Ltd, a company holding an oyster lease in southern Tasmania, about the feasibility of growing Pacific oysters on long lines in South Australian waters. It also raised the possibility of establishing a co-operative venture hatchery in South Australia to remove the dependency on spat derived from a wild population in the River Tamar. The Department arranged a meeting between representa-

tives of this company and Oyster Farmers Coffin Bay. A beneficial outcome of this meeting was that Pacific Aquaculture had been granted permission to put down two experimental long lines seeded with oysters from their Tasmanian lease. One long line was located off Streaky Bay near Boston Island and the other in Proper Bay, west of Horse Rock, Port Lincoln. The subsequent growth of these oysters was excellent and by October, 1974, they averaged 7 cm in length. As the oysters grew their added weight dragged longline floats underwater until the bottom section lay on the sea floor. Starfish then attacked the oysters and about 10% were lost. Arrangements for additional flotation to be added, as needed, had broken down and the interstate company did not proceed any further with its longline experiments.

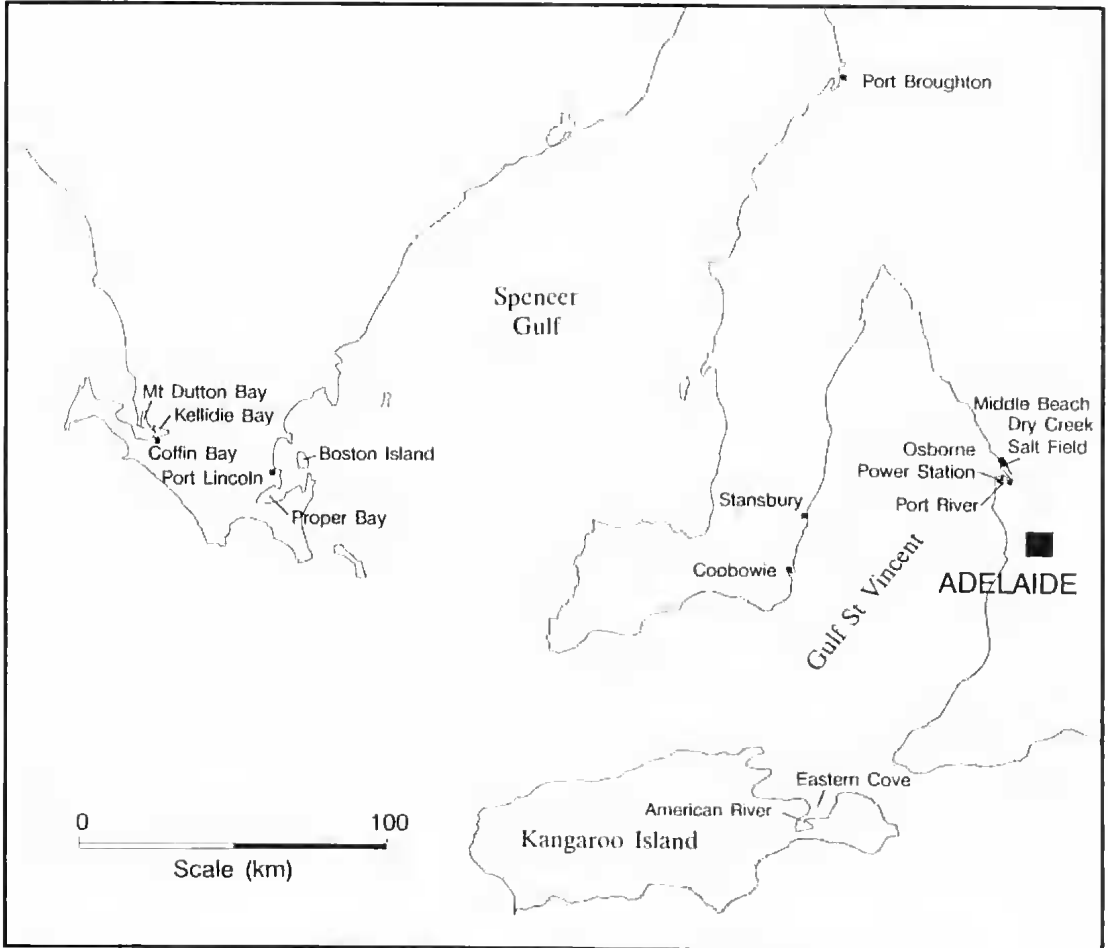


Fig. 2. Locations where attempts were made to grow introduced rock oysters.

From 1968 the Department of Fisheries had been involved in surface and ecological studies and more recently it had carried out similar studies under contract to other government departments and agencies. In late 1973, M. V. Melvin, Senior Production Officer, Alkali and Chemical Group, ICI, approached the Department to undertake for ICI a contract ecological survey of the large 3 km² primary pond of the solar salt evaporation complex at Dry Creek. He was examining the feasibility of a multipurpose use of this pond for aquaculture of the western king prawn, *Penaeus latiusculatus* or any suitable fish species (Reschke 1977³). This primary pond ranges from 1.5 to 2.5 metres in depth, it is non-tidal and hypersaline (annual mean salinity of 40.9 ppt).

An ecological study lasting two months undertaken in January-February 1974, showed that the pond could be suitable for an aquaculture use (King 1974). The author advised ICI against the aquaculture of prawns or fish because of predation by birds but rather to consider the cultivation of the Pacific oyster *C. gigas*. The recommendation was based on the successful establishment of reproducing stocks of the mussel *Modiolus inconstans* and the cockles *Kateleyia* spp. as well as the general high productivity of other biota in the pond. The recommendation was accepted by the Board of ICI, M. V. Melvin ICI and M. G. King, Department of Fisheries, were to be responsible for a co-operative study of growing Pacific oysters in the primary pond. Preliminary experiments were started with oysters from Oyster Farmers Coffin Bay while awaiting delivery of spat ordered from Tasmania. There was, however, a failure of the January-February 1974 spat settlement but with an out-of-season March spawning, Wivell Bros were able to fill the ICI order with spat settled on scallop shell cultch. The spat of 19 mm mean size were delivered and set out in the pond on July 4, 1974.

A small central hole had been punched in each cultch shell, enabling it to be threaded on a length of 3 mm diameter galvanised steel wire (ren). Nine to 12 cultch shells each carrying one to nine oysters were strung on each wire ren and separated by 10 cm lengths of plastic hose. These rens were hung from fixed wooden racks at three positions in the pond. By May 1975 growth averaged 15 g/month. The spat had a mean net weight of 2.1 g when placed in the pond and grew to a mean wet weight of 97.3 g in 9 months. King (1977) reported an acceptable market size of 70 g was attained after being in the pond for 8 months or within approximately 1 year of settlement.

Because of the success of the initial experiment with growing Pacific oysters in the primary pond, ICI in

mid 1975 approved a submission for funds for an on-going program for Pacific oysters in the primary pond at the Dry Creek salt fields. An order for 30,000 scallop shells averaging 8 spat/shell and 5,000 "sticks" averaging 40 spat/shell was placed with Wivell Bros. The consignment shipped from Burnie, Tasmania, arrived in Adelaide on July 25, 1975 and was planted out at selected positions in the pond (Melvin 1977).

By now there was a growing awareness of a developing South Australian oyster industry. Al Stansbury, J. McIntyre, who had been cultivating the mud oyster, *Ostrea angasi*, on his lease since about 1961, switched some of his cultivation to Pacific oysters in 1971. In April, 1975 B. Frankham, [lenley Beach, Adelaide, put out scallop cultch shells with spat from Wivell Bros on longlines in his deepwater lease at Eastern Cove, Kangaroo Island (Tilbrook 1977⁴). As Frankham was being advised by M. G. King, Department of Fisheries, he did not repeat the mistakes with flotation experienced earlier by Pacific Oyster Aquaculture at Port Lincoln.

The highlight of 1975 regarding the cultivation of Pacific oysters in South Australia was the success of an application by Director of Fisheries to the Government for the appointment of an oyster biologist experienced in oyster hatchery production. Dr. B. O'Sullivan from Carna Research Station, Galway Bay, Ireland was appointed to this position and arrived in Adelaide in March 1977.

In January 1976 ICI, on the recommendation of M. V. Melvin, brought Dr. D. B. Quayle, a Canadian oyster biologist and world authority on the cultivation of Pacific oysters to report on the new developments at Dry Creek saltfields. He was impressed by the growth of the Pacific oysters in the unusual environment of the primary pond of a solar salt field, an environment not previously considered to be suitable for oyster cultivation. Dr. Quayle provided practical advice on cultivation and harvesting techniques at Dry Creek.

There had been a number of approaches in the previous two years to the SA Government to support the building of a local hatchery for Pacific oysters to remove the dependency on spat derived from wild populations in Tasmania. There were two occasions, 1973 and 1974, when there was no spat settlement from the Tasmanian January-February spawnings.

Because of the unreliability of supplies of spat from Tasmania, M. V. Melvin had considered alternative sources of spat. On October 20, 1976 ICI submitted an application to import 50,000 cultchless spat of Pacific oyster from Scottish Sea Farms, Connell, Argyll, Scotland through the Minister of Fisheries, SA. This Scottish company was supplying certified disease-free cultchless oyster spat to buyers in Europe and South Africa. The parents of this source of spat were 6 adult Pacific oysters from Pendrill Sound,

³ RESCHKE, W. (1977) Here's news to rock those Sydney oysters. "Sunday Mail", 6 February, 1977.

⁴ TILBROOK, R. (1977) Down on the oyster farm. "Advertiser", 29 January, 1977.

British Columbia, Canada, imported by the Ministry of Agriculture and Fisheries Shellfish Culture Unit at Conway, Wales in June 1964. A year after the Minister had forwarded the ICI application, he was advised that the Advisory Committee on Import and Export of Live Fish of the Australian Fisheries Council had recommended that the proposal be approved. Another 12 months elapsed before formal written approval was received. There had been a rigorous examination by Commonwealth Quarantine and Department of Health authorities before permission to import cultchless spat from Scotland was granted. On arrival the spat were subjected to detailed quarantine inspection procedures and a period in quarantine. During the 2 year waiting period for approval to import spat, the 1977 River Tamar spat fall was a commercial failure with only 2 spat/scallop shell and 18 spat/"stick" being caught. This was the third failure in four years and highlighted the need for alternative sources of spat.

Early in 1977, a depuration unit was constructed and installed at Dry Creek. This apparatus used recirculated sea water, sterilised by irradiated UV light, to flush the gut of oysters. Oysters of marketable size were removed from the pond, separated from each other, cleaned externally with a jet of sea water and placed in the depuration unit where they remained for two days. This process was designed to prevent outbreaks of food poisoning such as had occurred in Victoria in 1975 and which had been attributed to infected NSW oysters. A trial marketing survey conducted in 1978 indicated a ready acceptance of the treated oysters. There were no requirements for depuration treatment of NSW commercial oysters until 1978-79 when it became mandatory following an extensive outbreak of food poisoning in that state from local oysters.

As a consequence of a favourable report from Dr Quayle after his Australian visit and the successful marketing of Pacific oysters from the primary pond, the Board of ICI approved M. V. Melvin's recommendation to build an oyster hatchery for Pacific oysters at Dry Creek. A draft agreement covering joint participation by ICI and SA Fisheries Research Branch in the design, commissioning and operation of an oyster hatchery at Dry Creek was received from the Board of ICI in March 20, 1978. Shortly after the agreement was signed on May 2, 1978, ICI advised that they had appointed Colin Palm, a Project Engineer with ICI, to be responsible for the design and construction of the hatchery through to commissioning. He was to be assisted throughout by his colleague, M. V. Melvin and B. O'Sullivan, the latter representing the SA Fisheries Research Branch of the now amalgamated Department of Agriculture and Fisheries. These three men brought chemical engineering and biological expertise to the design of the hatchery. Each aspect of the design and operation was carefully studied and operational difficulties were identified and where

possible either eliminated or reduced (Anon 1980). Copper, zinc, lead and their alloys were excluded from any contact with larvae or spat in the hatchery operations.

The 50,000 cultchless spat from Scotland, packed in mesh bags surrounded by damp newspaper to maintain a humid environment, arrived in Adelaide on September 14, 1978 in a polystyrene container. The spat were immersed in chlorinated fresh water for a few minutes and then rinsed in fresh water under supervision of quarantine officers before being set out on trays in the modified depuration unit. Water from the primary pond was pumped directly through the unit and discharged back into the pond for the quarantine period. The polystyrene container and newspapers were burnt under supervision.

Because of the failure of the 1977 Pacific oyster spat fall in Tasmania and the desire to maintain continuity of supply of adult oysters the Tasmanian fisheries authorities requested a permit to import one million cultchless oyster spat from Scottish Sea Farms. Permission was refused on the grounds that quarantine facilities in Tasmania were inadequate compared with the stringent conditions imposed at Dry Creek, South Australia.

It took only six months from the signing of the joint agreement in May until the designs of the building and equipment and the layout were approved in November, 1978. Seven months later the building was erected, equipment installed, tested and ready for commissioning. A fortnight later adults were brought into the hatchery from the primary pond for conditioning for spawning when required. At the same time the culturing of the algal food species for feeding the larvae and spat began. The first batch of one million oyster spat (1 mm in size) was placed in the pond on October 2 (Melvin 1979). They were expected to be ready for sale a year later after the depuration treatment. Batches in excess of one million spat were produced regularly thereafter (Olsen 1981).

In 1977 ICI Salthelds began an expansion program of the solar evaporative pond complex with the construction of a large impoundment at Middle Beach north of its original lease. New and more powerful pumps were installed to draw water from Gulf St Vincent. It was planned to incorporate the primary pond into the chain of ponds of increasing salinities.

By 1980 pumping of seawater into the primary pond from Chapman Creek was reduced and the new Middle Beach pond became the primary pond of the solar salt evaporative pond complex. Salinities in the former primary pond rose slowly to the required production level and consequently altered the long-established equilibrium environment there. Much of the biota identified in the January-February 1974 ecological survey failed to adapt to the water quality and salinity regimes. Thus the food of the oyster spat began to

decline as did the rate of growth of the oysters.

Coincidentally with this expansion of the production of solar salt was the widespread Australian drought. As a consequence of the drought conditions and lowered demand for agricultural chemicals and other products manufactured by ICI, the Board of ICI decided on a restructuring program of its Australian activities and to concentrate on production of its core products. It decided to withdraw from and close down its many diversified projects whether profitable or not. In 1983, the South Australian solar saltfield complex at Dry Creek was sold. The production of oyster spat ceased and the hatchery equipment was sold.

Fortunately for the developing South Australian oyster industry a new hatchery at Bicheno, Tasmania had come "on stream" in June 1981 so that the industry was no longer dependent on spat from the wild population of Pacific oysters in the River Tamar.

The success of the early aquaculture of Pacific oysters on leases in Kellidie Bay, Kangaroo Island,

Stansbury and in the original primary pond of the solar saltfield complex at Dry Creek stimulated the demand for leases for aquaculture of Pacific oysters. Initially there were 98 approved leases but when fees were introduced in 1992 this number dropped to 82. The present active, vigorous aquaculture of Pacific oysters in SA stems from the efforts and close co-operation between the fishery authority, three private individuals and one of the staff and resources of a large industrial manufacturing organisation.

Acknowledgements

I am extremely grateful to Dr S. J. Edmonds, Dr M. G. King and Mrs Jean Bird, Editor for their valuable constructive comments on an earlier draft of this manuscript. Thanks are due to Gavin Wright, South Australian Aquatic Sciences Centre for the preparation of the maps and Ms. S. Arnold for typing the manuscript.

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